Dataset for the reporting of carcinoma of renal tubular origin: recommendations from the International Collaboration on Cancer Reporting (ICCR)

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Abstract: AIMS The International Collaboration on Cancer Reporting (ICCR) has provided detailed datasets based upon the published reporting protocols of the Royal College of Pathologists, The Royal College of Pathologists of Australasia and the College of American Pathologists. METHODS AND RESULTS The dataset for carcinomas of renal tubular origin treated by nephrectomy was developed to provide a minimum structured reporting template suitable for international use and incorporated recommendations from the 2012 Vancouver Consensus Conference of the International Society of Urological Pathology and the fourth edition of the World Health Organization Bluebook on tumours of the urinary and male genital systems published in 2016. Reporting elements were divided into those, which are Required and Recommended components of the report. Required elements are; specimen laterality, operative procedure, attached structures, tumour focality, tumour dimension, tumour type, WHO/ISUP grade, sarcomatoid/rhabdoid morphology, tumour necrosis, extent of invasion, lymph node status, surgical margin status, AJCC TNM staging and co-existing pathology. Recommended reporting elements are; pre-operative treatment, details of tissue removed for experimental purposes prior to submission, site of tumour(s) block identification key, extent of sarcomatoid and/or rhabdoid component, extent of necrosis, presence of tumour in renal vein wall, lymphovascular invasion and lymph node status (size of largest focus and extranodal extension). CONCLUSIONS It is anticipated that the implementation of this dataset in routine clinical practise will inform patient treatment as well as provide standardized information relating to outcome prediction. The harmonisation of data reporting should also facilitate international research collaborations.

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ABSTRACT

Aims: The International Collaboration on Cancer Reporting (ICCR) has provided detailed datasets based upon the published reporting protocols of the Royal College of Pathologists, The Royal College of Pathologists of Australasia and the College of American Pathologists. *Methods and results:* The dataset for carcinomas of renal tubular origin treated by nephrectomy was developed to provide a minimum structured reporting template suitable for international use and incorporated recommendations from the 2012 Vancouver Consensus Conference of the International Society of Urological Pathology and the fourth edition of the World Health Organization Bluebook on tumours of the urinary and male genital systems published in 2016. Reporting elements were divided into those, which are *Required* and *Recommended* components of the report. Required elements are; specimen laterality, operative procedure, attached structures, tumour focality, tumour dimension, tumour type, WHO/ISUP grade, sarcomatoid/rhabdoid morphology, tumour necrosis, extent of invasion, lymph node status, surgical margin status, AJCC TNM staging and co-existing pathology. Recommended reporting elements are; pre-operative treatment, details of tissue removed for experimental purposes prior to submission, site of tumour(s) block identification key, extent of sarcomatoid and/or rhabdoid component, extent of necrosis, presence of tumour in renal vein wall, lymphovascular invasion and lymph node status (size of largest focus and extranodal extension).

Conclusions: It is anticipated that the implementation of this dataset in routine clinical practise will inform patient treatment as well as provide standardized information relating to outcome prediction. The harmonisation of data reporting should also facilitate international research collaborations.

Key words: renal cell carcinoma, nephrectomy, datasets, tumour, grading, staging.

Introduction

Several studies have demonstrated that a structured approach to pathology reporting improves the completeness and quality of reports by ensuring that all essential information necessary for diagnosis and prognostic assessment is included.[1-4] The use of a structured format has also been shown to be superior to that of a narrative report with regard to readability and to access of information. In particular all the essential factors are presented in a list or table with headers and responses, rather than being buried in long narrative text.[5]

As a result of these studies, the development of structured reporting checklists has been advocated internationally over the past two decades and in particular pathologists from Australia,[6] the United Kingdom[7] and the United States of America[8], have, for some years, produced standardised cancer reporting protocols for national implementation. While each of the protocols for specific organs are similar in nature, having an evidence-based approach, each jurisdiction has developed their cancer checklists in a different manner, employing differing terminology. This means that in some instances descriptions of similar elements may vary in meaning, impeding the possibility of international collaborative research and benchmarking studies.

With the ever-rising complexity of cancer diagnosis and treatment, the availability of standardised evidence-based checklists for each type of cancer is of increasing value to pathologists worldwide. Given this, a consortium of pathology colleges, societies and major cancer organisations agreed to collaborate on the production of standardised reporting checklists and piloted the development of four internationally standardised cancer reporting protocols in 2011. The initial pilot project to develop four cancer datasets – Melanoma, Endometrium, Prostate (Radical Prostatectomy specimen) and Lung – provided an opportunity to trial a number of development methodologies. From this the current framework for the development of datasets emerged and is published in Guidelines for the Development of ICCR Cancer Datasets.[9] Based upon the success of this project the International Collaboration on Cancer Reporting (ICCR) was formed with the goal of producing unified, internationally validated and evidence-based pathology datasets for cancer reporting, for use internationally.

This process of compiling datasets by the ICCR is based on the development of a single cancer dataset with the aid of a Dataset Authoring Committee (DAC). Of primary importance to the DAC is the selection of a chair by the Dataset Steering Committee (DSC) to oversee the development process. Once appointed, the chair assists the DSC to identify members of the DAC. The DSC, in convening a DAC for a specific cancer seeks members covering a wide geographic and linguistic diversity, as well as having a high level of expertise in the specific cancer.

The current review presents the recommendations of the DAC in relation to the development of a structured reporting protocol for kidney specimens containing renal cell neoplasia, obtained through either partial or total nephrectomy, usually undertaken with a curative intent. The protocol incorporates the recommendations of the International Society of Urological Pathology (ISUP) Vancouver Conference on Renal Neoplasia,[10] the 2016 World Health Organization (WHO) Classification of Renal Tumours[11] and the eighth edition of the American Joint Committee on Cancer TNM Staging Classification of 2017.[12] It is anticipated that the recommended elements will provide contemporary guidance for the reporting of renal malignancies and that reports which adhere to these guidelines will contain sufficient data to inform both patient treatment and outcome prediction.

Methods

The DAC convened for the construction of the renal cancer dataset consisted of 14 members. Twelve of these were urological pathologists with special expertise in renal cancer, one of the members was a urologist while the final member was the ICCR Project Manager who assisted in all aspects of the development process. An ICCR representative was also appointed to the committee with the role of providing guidance and support to the Chair of the DAC regarding ICCR standards. In addition to an authoring function, the ICCR representative had a quality assurance role within the committee, to ensure adherence to ICCR guidelines relating to evidence-based recommendations. For the renal cell carcinoma (RCC) protocol, the ICCR representative also co-chaired the development process.

The renal cancer reporting protocol was initially drafted by the Chairs of the DAC and the ICCR Project Manager, following a detailed review of published datasets/protocols and relevant articles. Importantly *Required* and *Recommended* elements of the reporting protocols were identified. *Required* elements are those for which there was unanimous agreement by the committee that the element was essential for histological diagnosis, clinical management, staging and/or assessment of prognosis. *Required* elements are mandatory elements of a pathology report and the sum of these is

the minimum information which should be included in the report. Evidentiary support at Level III-2 or above, based on prognostic factors in the National Health and Medical Research Council (NHMRC) levels of evidence document and defined as "Analysis of prognostic factors amongst persons in a single arm of a randomised controlled trial",[13] was required to support *Required* (mandatory) elements. Rarely, where Level III-2 evidence was not available, an element was categorised as *Required* with unanimous agreement of the expert panel. *Recommended* elements are those which were considered non-mandatory but defined as being clinically important and recommended as appropriate for good practice. It was agreed that *Recommended* elements should ideally be included in a pathology report although they have not yet been validated by evidence, or are not regularly utilized in patient management. Commentary, by way of explanatory text, diagrams or tables was included in the draft dataset, and was added to clarify the elements and to further define the manner in which an item should be reported in order to; foster reproducibility, provide an explanation why an element is included in the dataset by specifying how the item will assist with clinical management of the specific cancer, cite published evidence in support of the inclusion of the element, and to clarify any exceptions or issues that may be encountered by the reporting pathologist.

The draft dataset was formatted into a 'voting' document and circulated to the DAC for feedback. This feedback was then compiled and provided back to the DAC prior to a series of web meetings/teleconferences to discuss the elements.

Once agreed by the DAC, the dataset was posted to the ICCR website for an 8 week period of public consultation. Following the open consultation phase, feedback was reviewed and relevant changes drafted. At this stage a decision was made by the ICCR to incorporate the eighth edition TNM staging system and dataset publication was delayed until this could be included. Following publication of the eighth edition TNM by the AJCC, the dataset was revised and updated, reviewed by the DAC and changes finalised and ratified by the DSC.

Results

This dataset was developed for the reporting of renal excision specimens where the operation was undertaken for the treatment of carcinomas of renal tubular origin. If there is more than one tumour in a kidney or if tumours are bilateral, then multiple datasets should be used. The dataset is not intended for tumours that are not of renal tubule origin, including urothelial carcinoma arising from the upper renal tract, Wilms tumour and other nephroblastic and mesenchymal tumours.

Required dataset elements

The Required elements in the dataset are listed in Table 1.

Specimen laterality

Information regarding the laterality of the specimen is a requirement for patient/specimen identification purposes and furthermore assists the pathologist in orienting the specimen prior to gross dissection.

Operative procedure

The nature of the surgical procedure should be recorded for medico-legal purposes and to assist the identification of both the patient and specimen. Three surgical techniques are routinely employed;

- A radical nephrectomy specimen is defined as a resection of Gerota's fascia and its entire contents including the kidney, perinephric fat and lymphatics, as well as a length of ureter. The specimen may or may not include the ipsilateral adrenal gland.
- A simple nephrectomy results in the removal of a kidney including a small length of ureter.
- A partial nephrectomy specimen varies from local resection of the tumour with a thin rhind of apparently normal renal tissue, to a segment of a tumour-bearing kidney containing variable portions of the calyceal or renal pelvic collecting system.

The nature of the surgical procedure is also of importance when determining the assessment of surgical margins. While all surgical margins should be evaluated, it is especially important for partial nephrectomy specimens that the intra-renal surgical margin be carefully evaluated, so as to ensure that no residual tumour is present in the remaining renal tissue.

Accompanying/attached structures

Occasionally tissues, other than the usual structures removed during the nephrectomy procedure, are received as part of the operative specimen. These may include contiguous structures infiltrated by tumour or affected by concomitant inflammation/infection. These may also include tissues containing local or distant metastases. These tissues should be recorded for patient/specimen identification purposes, while their subsequent histological assessment will inform tumour staging.

Tumour focality

Although clear cell RCCs are usually solitary, other morphotypes of renal cell neoplasia, especially papillary RCCs and carcinomas arising in the setting of acquired cystic/ end-stage renal disease, are more commonly multifocal. The presence of multiple tumours in a nephrectomy specimen may be the only indication that the tumours may be part of a hereditary syndrome associated with the development of RCC, in particular von Hippel Lindau, Birt-Hogg-Dubé and hereditary papillary carcinoma syndromes. If multiple carcinomas are present it is important that this be recorded and a separate protocol used for each tumour. In particular it is important to record the diagnostic and prognostic parameters associated with the most significant tumours (largest, highest pT-category, highest grade). The histological subtype of the tumours may be similar or different, and occasionally diverse morphotypes may be present in the same kidney. When numerous carcinomas are present the recommendation is that the details of the 5 largest tumours should be recorded.[14]

Maximum tumour dimension

Measurement of tumour size is necessary for staging purposes as this is the defining feature of the pT1 and pT2 staging categories of the AJCC TNM staging classification.[12] Further it has been shown that for clear cell RCC tumour size correlates with outcome as a continuous variable and also predicts renal sinus invasion.[15,16]

Measurement of tumour size should be undertaken following detailed dissection of the gross specimen and the greatest dimension should be recorded. Tumour extending into extracapsular tissue and/or the renal sinus, in continuity with the primary intra-renal tumour should be included in the measurement, while tumour within the renal vein and beyond should not be included. If multiple tumours are present, the greatest dimension of the five largest tumours should be recorded.[14]

Histological tumour type

Many of the various morphotypes of renal epithelial neoplasia exhibit varying clinical behaviour and prognosis.[11,12,17-22] This has been confirmed in large single and multicentre studies for the main tumour sub-types. Several series have also clearly demonstrated that many of the newly described entities of renal malignancy have a prognosis that differs from that of clear cell RCC.[22] In addition to this, protocols for the various adjuvant therapies relate to specific tumour morphotypes. [23]

Currently recognized morphotypes of RCC are shown in Table 2. Papillary RCC has traditionally been subdivided into Type 1 and Type 2.[24] Recent studies have shown these tumours to be clinically and biologically distinct. Type 1 tumours are associated with alterations in the *MET* pathway while type 2 tumours are associated with activation of the *NRF2-ARE* pathway. On the basis of molecular features type 2 tumours may be sub-divided into at least 3 subtypes.[25] Type 1 and type 2 tumours show differing immunohistochemical staining, with type 1 tumours more frequently expressing cytokeratin 7 in comparison to type 2.[10,11,24,25] Oncocytic papillary RCC is an entity included in the fourth edition of the WHO renal tumour classification.[11] While not fully characterized, it is recommended that this tumour be included in the broader papillary RCC category as a specific subtype.

The 2012 ISUP Vancouver Classification of Renal Tumours defined a novel classification category for newly described RCC. These were designated emerging/provisional morphotypes.[10] While appearing distinctive, these rare tumours had not been fully characterized by morphologic, immunohistochemical and molecular studies at the time of publication of the Classification. This category was also included in the fourth edition of the WHO classification of renal neoplasia. In the WHO classification oncocytoid RCC post-neuroblastoma, thyroid-like follicular RCC, anaplastic lymphoma kinase (*ALK*) rearrangement-associated RCC and RCC with (angio) leiomyomatous stroma were included in this category. These entities, as well as more recently reported emerging RCC morphotypes (multiple oncocytoma-like tumours associated with oncocytosis, biphasic alveolar squamoid RCC and eosinophilic solid and cystic RCC)[26-28] should be classified under 'other' with the name of the tumour specified.

The prognosis of RCC varies according to morphotype. Papillary RCC is associated with a more favourable outcome than clear cell RCC. A more favourable outcome has also been reported for multilocular cystic renal neoplasm of low malignant potential, mucinous tubular and spindle RCC, clear cell papillary RCC and tubulocystic RCC, while collecting duct carcinoma, acquired cystic disease of kidney-associated RCC and hereditary leiomyomatosis-associated RCC have a less favourable prognosis.[11,22] Papillary subtyping is also of prognostic significance with type 1 tumours having a better prognosis than those with type 2 morphology.[22,24,25]

Histological grade of tumour

The WHO/ISUP grading system for RCC is shown in Table 3. This grading system was adopted by the 2012 Vancouver Consensus Conference on Renal Neoplasia and was endorsed by the WHO, being included in the fourth edition of the Bluebook Classification of Renal Tumours.[11,22] This system has been validated as a prognostic parameter for clear cell and papillary RCC.[22,29-31] The current recommendation is that chromophobe RCC is not graded.[11,32] While the grading system has not been validated for other tumour types it may be used for descriptive purposes with an added note that the grading should not be taken as a prognostic indicator.[33] Grade should be based upon the single high power field showing the highest grade.

Sarcomatoid morphology

The presence of Sarcomatoid morphology in RCC represents epithelial-mesenchymal transformation and is seen in approximately 5% of RCCs. This morphology represents a de-differentiation end point for RCC and is associated with a poor prognosis.[22,34-37] Numerous studies have confirmed that sarcomatoid morphology may occur within any of the recognized morphotypes of RCC and is a feature of high grade disease, with an associated poor prognosis.[10,11] The five year survival for patients with sarcomatoid morphology ranges from 15 to 22% and is stage dependent.[10,11,22,34-38] While the presence of sarcomatoid morphology should be reported separately, it is also a defining feature of WHO/ISUP grade 4 tumours.[22]

Rhabdoid morphology

Similar to sarcomatoid morphology, rhabdoid morphology in RCC is a feature of high grade disease.[22,39] Tumours showing this phenotype resemble rhabdoid cells having bulky eosinophilic cytoplasm and an eccentric nucleus, often with a prominent nucleolus.[10,11] Several studies have confirmed that rhabdoid morphology is associated with a poor prognosis, with 71% of patients with developing metastases over a mean follow-up of 4.5 months. In a separate study it was noted that 43% of patients had died within 2 years, with survivals ranging from 8-31months.[22,39-41] In approximately 25% of tumours with rhabdoid morphology, there is co-existing sarcomatoid carcinoma.[11] In addition to the separate reporting of rhabdoid morphology in RCC, this is also incorporated into the WHO/ISUP grading system as a feature of Grade 4 tumours.[22]

Necrosis

The presence of tumour necrosis has been shown to be a prognostic indicator for clear cell and chromophobe RCC independent of tumour stage.[22,42] Papillary RCC typically contains foci of necrosis, however the prognostic significance of this is, at best, debated. At present it is recommended that the presence of both macroscopic and microscopic (coagulative) necrosis be recorded.[22] Where previous renal biopsy has been undertaken, this may result in biopsy-related necrosis which may not have the same prognostic association. For patients who have undergone pre-surgical renal embolization, the degree of tumour-related necrosis cannot be assessed.

Extent of tumour invasion

Most macroscopic and microscopic features relating to the extent of invasion by tumour are *required* dataset elements although the presence of tumour in the wall of the renal vein is a *recommended* element (Tables 1 and 4).

The extent of tumour invasion must be recorded as "tumour limited to the kidney" or recorded for each of the following:

- Tumour spread beyond the renal capsule
- Tumour in renal sinus
- Tumour extends beyond Gerota's fascia
- Tumour in major veins (renal vein or its segmental branches, inferior vena cava)
- Tumour in pelvicalyceal system
- Tumour in adrenal gland
- Tumour in other organs/structures

Extra-renal extension of tumour is a feature of pT3 and pT4 staging categories of the TNM staging classification (Table 5). The determination of extrarenal extension of tumour into peri-renal fat requires histological evidence of tumour beyond the renal capsule.

The renal sinus is the compartment that lies between the renal parenchyma and the renal pelvis and calyces. This compartment contains varying amounts of fat and is rich in lymphatics. As a consequence infiltration of the renal sinus is the principal route for the extension of tumour beyond

the kidney.[41] The identification of tumour directly infiltrating the renal sinus or large vessels has prognostic significance and this information is required for staging purposes.[12,43] Infiltration of the renal sinus is often an under-recognized phenomenon.[44] In view of this the renal sinus fat should be carefully assessed and generously sampled in order to detect renal sinus fat involvement. If renal sinus invasion is seen on gross inspection of the specimen, then only one confirmatory section need be taken. If there is no evidence of renal sinus invasion grossly, then sampling should consist of at least three blocks of tissue.[14] Histologically renal sinus invasion is confirmed when there is tumour in contact with renal sinus fat, within the loose connective tissue clearly beyond the renal parenchyma of the renal sinus or in endothelial-lined spaces (with or without mural smooth muscle) within the renal sinus (Fig. 1).[41] It is likely that renal sinus invasion is preceded by involvement of renal sinus veins. Renal sinus invasion is most commonly seen in clear cell RCC and for this RCC morphotype appears to be associated with tumour size. In particular it has been noted that in clear cell RCC s $\geq$ 7cm in diameter, renal sinus invasion was seen in > 90% of cases.[16,45] For this reason the AJCC recommend that in tumours >7cm diameter renal sinus invasion should be suspected and sampling should be appropriately targeted.[12]

Involvement of the renal sinus by tumour is a feature of pT3a tumour staging category of the TNM classification (Fig. 2). It has also been shown that involvement of lymphatics within the renal sinus is of prognostic significance.[46] There is evolving literature suggesting that renal sinus fat involvement predicts a more aggressive outcome than peripheral perinephric fat invasion.[16,45]

Careful gross examination of the specimen to assess large vessel invasion for example of the renal vein or beyond (if applicable) should be undertaken and any observation should be confirmed by histological evaluation.

Macroscopic infiltration rather than microscopic evidence of invasion of the renal vein was a feature of pT3a in earlier editions of the TNM classification, however, it has been shown that microvascular invasion correlates with outcome independent of T category, grade and perirenal fat invasion.[47] Further, it is appreciated that infiltration of the renal vein may be overlooked on gross examination. For this reason the qualifier “grossly”, in relation to renal vein invasion, was removed as part of the definition of the pT3a staging category in the eighth edition of the AJCC staging system. Extension of tumour beyond Gerota’s fascia is a feature of the pT4 staging category of the TNM staging system. (Fig. 3).[12]

When renal carcinoma involves the adrenal gland, it is important to document whether the involvement is contiguous spread of tumour or a separate (non-contiguous) nodule of carcinoma.[12] It is now recognized that direct spread of tumour to the ipsilateral adrenal gland has an outcome similar to pT4 tumour (Fig. 4).[48,49] In earlier TNM classifications this was included in the pT3a category, however, in view of these recent findings this was included as a feature of the pT4 category in the seventh edition of the UICC TNM classification. In contrast a discrete, separate nodule in the adrenal gland is considered M1 disease.[12]

The presence of metastatic disease at any site (excepting lymph nodes) is the defining feature of the pM1 staging category of the TNM staging classification.[12]

Lymph node status

In earlier editions of the UICC/AJCC TNM classifications, the number of lymph nodes infiltrated by tumour was used to differentiate pN categories. This classification has been now been simplified and the requirement is that the presence or absence of lymph node involvement by tumour must be recorded.[11]

Margin status

Assessment of surgical margins is important in determining if residual tumour is present either in the residual kidney, for partial nephrectomy specimens or in the renal bed for nephrectomy specimens. For a partial nephrectomy specimen, the renal parenchymal margin should be inked and sampled widely for histological assessment. Most partial nephrectomy specimens also contain a portion of perinephric fat overlying the tumour site and this margin should also be assessed. In situations where no perirenal fat is submitted, the renal capsular margin should be inked and examined histologically. In nephrectomy specimens the ureteric, major vascular (renal vein, renal artery) and soft tissue (peri-renal fat and Gerota's fascia for radical nephrectomy specimens), including renal sinus margins, should be examined and documented in the report. There was consensus in the ISUP Vancouver Consensus Conference that a renal vein margin should be considered positive only if there was adherent tumour at the margin and that this had been confirmed microscopically.[14]

Co-existing pathology in non-neoplastic kidney

It is important to recognize that renal neoplasia may co-exist with non-neoplastic renal disease and that this may be evident in nephrectomy and nephroureterectomy specimens.[50,51] Arterionephrosclerosis (or hypertensive nephropathy) is identified in up to 30% of cases while other renal diseases that may more commonly be encountered are diabetic nephropathy thrombotic microangiopathy, focal segmental glomerulosclerosis, and IgA nephropathy. If there is > 20% global glomerulosclerosis or advanced diffuse diabetic glomerulosclerosis then this is predictive of significant decline in renal function 6 months following radical nephrectomy.[51] Detailed evaluation for the presence of non-neoplastic renal disease should be performed in each case and if necessary PAS and/or Jones methenamine silver stained sections should be obtained. Where appropriate, consultation with a nephropathologist should be requested.

Pathological staging summary

This dataset is based upon the definitions and recommendations of the eighth edition of the American Joint Committee on Cancer TNM staging classification published in 2017[12] (Table 5). This was implemented internationally in January 2018.

Recommended dataset elements

Those elements which are not a required component of a pathology report, but which provide important information that relates to diagnosis, treatment and/or prognostic assessment, are classified as *recommended* elements and are listed in Table 4.

Pre-operative treatment

Pre-operative treatments may significantly alter the gross and microscopic appearance of the tumour.

Tissue removed from specimen prior to submission

In some laboratories tissues are removed for biobanking and research purposes. It must be noted that pathologic evaluation of any surgical specimen requires a detailed examination of the complete specimen. If tissue has been removed prior to examination this could compromise diagnosis, staging and prognostic assessment. As a consequence it is recommended that experimental tissues be removed

by the reporting pathologist or if this is not possible, that the site of sampling be carefully documented to ensure that reporting is not compromised.

Tumour site(s)

Documentation of the position of the tumour in relation to the boundaries of the kidney and the surgical resection margin is important for staging purposes, for both radical nephrectomy and partial nephrectomy specimens. The position of the tumour in relation to the renal cortex or medulla may also have diagnostic importance. This is especially important for small tumours where a site of origin within the medulla would support a diagnosis of collecting duct carcinoma or medullary carcinoma.[11] For partial nephrectomy specimens it is recommended that the distance from the tumour to the closest surgical margin should be measured.

Block identification key

The site of sampling of all tissue blocks removed from the surgical specimen should be recorded. This information should be documented in the final pathology report and is particularly important should the need for internal or external review arise. In such instances the reviewer needs to be clear as to the origin of each block in order to provide an informed specialist opinion. If this information is not included in the final pathology report, it should be available on the laboratory computer system and relayed to the reviewing pathologist. Recording the site of origin of tissue blocks also facilitates retrieval of blocks for further immunohistochemical or molecular analysis, research studies and clinical trials.

Extent of sarcomatoid component

It has been suggested that the proportion of tumour showing sarcomatoid differentiation has prognostic significance. There is no recommended or agreed method to calculate the sarcomatoid component at present; however, significantly different survival intervals have been demonstrated for tumours divided with a cutpoint of <50% and ≥50% sarcomatoid component and these data may be included in the report.[22,37]

Extent of rhabdoid component

There is currently no firm evidence to demonstrate that the volume of cells showing rhabdoid morphology is of prognostic significance.[22]

Extent of necrosis

The presence of tumour necrosis has been shown to be a prognostic indicator for clear cell RCC but has limited or no prognostic implications for papillary RCC. It has also been shown that tumour necrosis involving >10% of the tumour is associated with a less favourable outcome, while for AJCC TNM stage 1 and 2 tumours, a cutpoint of 20% of the area of the tumour showing necrosis has been suggested to have prognostic significance.[52] Although the prognostic significance of the amount of necrosis within a tumour is uncertain, it has been recommended that this be recorded as a percentage of the total area of tumour sampled,[22] determined by gross and microscopic examination.

Lymphovascular invasion

Lymphovascular invasion includes intratumoral, peritumoral and perirenal space invasion.[53] In the renal sinus, it may be difficult to distinguish microscopic lymphovascular invasion from involvement of thin walled veins lacking smooth muscle. From a practical perspective, the presence of either pattern should be considered as renal sinus involvement with a staging category of pT3a.

Microvascular invasion has been shown to correlate with the development of metastases and with survival, independent of tumour size, primary tumour category, and grade.[54]

In both clear cell and papillary RCC, tumour spread is predominantly haematogenous via the sinus veins, renal vein and vena cava to the lung. Infiltration of the perirenal fat can result in retroperitoneal spread. Lymphatic spread to the nodes of the renal hilum may also occur and is more common in papillary RCC than clear cell RCC.

Ancillary findings

Ancillary studies are being increasingly utilized for subtyping of renal cell neoplasms. Fluorescent *in-situ* hybridization (FISH) can be used to confirm a diagnosis of translocation carcinoma (MiT family tumour) and has been shown to be of utility in distinguishing oncocytoma from chromophobe RCC.[11] Cytogenetics may be undertaken in some instances; however, this is not usually performed as part of the routine assessment of a renal tumour. It is now recognized that immunohistochemical assessment of tumours can be diagnostically helpful.[55] There are currently no ancillary tests that are accepted as having prognostic significance for renal cell neoplasms.[55,56]

Discussion

In 2014, the ICCR made the decision to develop cancer datasets in synchrony with the release of the fourth edition of the WHO Classification of Tumours Bluebooks. The WHO Classification of Tumours of the Urinary System and Male Genital Organs was published in 2016 and following this a suite of 12 datasets for genitourinary cancer was planned. With the publication of the eighth edition of AJCC TNM Staging Classification towards the end of 2016, the ICCR delayed publication of the genitourinary tumour datasets in order to ensure that the final published versions were current with the latest staging requirements.

The initial framework of these ICCR datasets was expanded in 2016, with the introduction of a Series Champion role. This role was introduced to provide advice and support to the Chairs of the DACs within a specific anatomical series to ensure harmonization across the datasets under development. As this role was identified after the commencement of work on the genitourinary tumour datasets, the ICCR representative for the genitourinary suite was also appointed Series Champion. In the development of subsequent series of datasets these roles have been separated.

This dataset was developed for excision specimens of the kidney specifically for the reporting of invasive carcinoma of renal tubular origin. A second dataset has been developed for renal biopsies for tumour and this is not discussed here.

The dataset incorporates contemporary tumour classification and staging systems and consists of 13 *required* elements and 9 *recommended* elements. In addition two multipart elements i.e. lymph node status and extent of invasion, include both *required* and *recommended* components.

Considerable advances have been made in our understanding relating to the diagnosis and classification of the various morphotypes of RCC and this has informed the development of a variety of adjuvant therapies of utility in the treatment of patients with advanced disease. In addition to this detailed studies on prognostic parameters for these tumours have led to the development of validated grading and staging systems. Despite this several areas of contention remain.

One of the most challenging issues associated with the classification and prognostic assessment of RCC is the ever-increasing list of morphotypes of renal cell neoplasia. The current WHO classification recognizes 14 varieties of RCC and in the intervening four years since the publication of the fourth edition of the WHO Bluebook,[11] four additional morphotypes have been characterized to the extent that are likely to included in the next formal classification of renal cell neoplasia (thyroid-like follicular RCC, multiple oncocytoma-like tumours associated with oncocytosis, biphasic alveolar squamoid RCC and eosinophilic solid and cystic RCC).[26-28] While it is clear that each form of RCC is a unique morphotype there are limited data relating to the clinical behaviour of some of the tumour types. It is recognized that TNM staging and WHO/ISUP grading does provide useful prognostic information regarding outcome assessment for clear cell and papillary RCC. The significance of these parameters is less certain or indeed unknown for several of the more recently described RCC morphotypes, due to the limited number of cases with follow-up that have been reported. In view of this there is an urgent need for international collaborative studies to fully characterize many of the recently described types of RCC.

The prognostic significance of TNM staging of RCC has been validated in multiple studies since the release of the first UICC TNM classification in 1978.[57] While the recently published eighth edition of the TNM classification from both the UICC and AJCC has incorporated recommendations arising from recent studies and contemporary practise, inconsistencies between these two classifications have been noted[58] and as a consequence the AJCC version[2] has been preferred and adopted by the ICCR.

An important outstanding issue relating to staging of RCC concerns the potential overlapping features of pT2 and pT3a staging categories. pT2 tumours are defined on the basis of primary tumour size (>7cm), while pT3a requires infiltration into the renal vein/ segmental branches, pelvicalyceal system or into the renal sinus.[12] There is some evidence to indicate that up to 97% of tumours >7cm diameter show renal sinus invasion[16] and, as such, tumour size could be considered a surrogate marker of this. Detailed studies are required to independently determine the relationship between tumour size and renal sinus invasion and that, if appropriate, the defining features of pT2 and pT3a staging categories be adjusted accordingly.

The presence of tumour within lymph nodes is the sole definition of N category status in the AJCC TNM classification. In earlier versions of the classification quantitation of positive nodes was required to determine whether node positive tumours should be categorized as N1 (metastasis in a

single regional lymph node) or N2 (metastases in more than one regional lymph node), and this impacted upon stage grouping. An early study appeared to validate this sub-division of N positive tumours, as it was found that the N category was significantly associated with outcome.[18] Closer scrutiny of the Kaplan-Meier curve in that study shows similar survival for N1 and N2 cases and it is apparent that the significant result reported simply reflects the difference between node positive and node negative cases. The lack of prognostic significance of cases divided according to the number of nodes containing metastatic tumour has been confirmed in a subsequent study.[59] Of interest; however, this study did show that extra-nodal extension of tumour is of prognostic significance, although this has yet to be incorporated into TNM staging.

Grading of RCC has been recognized as an important prognostic parameter since the time of Skinner's landmark studies.[57] More recently, refinement of grading criteria has led to the development of validated grading classifications for clear cell and papillary RCC.[22] As noted above, grading is one of the parameters that requires validation for many of the recently described morphotypes of RCC.

Tumour necrosis is recognized as an important prognostic indicator, especially for clear cell RCC, although there is currently some confusion relating its classification and reporting. It is apparent that two separate processes may lead to the development of necrosis in clear cell RCC.[60-63] Classical coagulative necrosis, usually from vascular occlusion with subsequent infarction is usually visible macroscopically and may be extensive. A separate form of tumour necrosis, which is rather confusingly designated microscopic coagulative necrosis (MCN) appears to develop via a different pathogenic mechanism. Despite the terminology, MCN may be macroscopic and does not have the typical appearance of coagulative necrosis; however, it is the presence of this type of necrosis that appears to have importance as a prognostic indicator. The presence or absence, as well as the percentage of tumour showing MCN has been correlated with surrogate prognostic markers and patient outcome.[60,62,64] It is unfortunately evident that several studies have confused the two types of necrosis and the current recommendations of both the ISUP and the WHO are that both types of necrosis should be recorded, which serves to confound prognostic assessment. Separate studies relating to tumour outcome have shown the MCN provides survival information additional to tumour grading and for this reason it has been suggested that MCN status should be incorporated into the WHO/ISUP grading classification for clear cell RCC.[60]

The presence of sarcomatoid and/or rhabdoid differentiation is incorporated into tumour grading criteria for both clear cell and papillary RCC.[22] The presence of these morphologies also appears to be associated with a similar poor prognosis for other RCC morphotypes.[11] At present the prognostic predictive value resulting from quantitation of the percentage of sarcomatoid differentiation within a tumour is uncertain. Some studies have indicated the presence/absence alone is of prognostic significance, while others have shown that there is an association between the percentage of tumour showing sarcomatoid morphology and decreased survival.[34,35,58] Similarly it has been suggested that the percentage of high grade (grade 4) tumour present may influence outcome, although this remains to be formally validated.[65]

All ICCR datasets are freely available for worldwide use at the following website: http://www.iccr-cancer.org/datasets.

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Authors contributions

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Figure legends

Figure 1

Renal malignancy constrained by the renal capsule (arrow), yet no fibrous capsule impedes its growth into the vascular tissue of the renal sinus (curved arrows).

From Bonsib et al.[46] *The American Journal of Surgical Pathology. © 2000 Wolters Kluwer Health.*

Figure 2. T3a

Invasion into perirenal and/or renal sinus fat but not beyond Gerota's fascia.

From the American Joint Committee on Cancer (AJCC), Chicago, Illinois. The original source for this material is the AJCC Cancer Staging Atlas 2nd edition (2010) published by Springer Science and Business Media LLC, www.springerlink.com.

Figure 3.

T4 Invasion beyond Gerota's fascia.

From the American Joint Committee on Cancer (AJCC), Chicago, Illinois. The original source for this material is the AJCC Cancer Staging Atlas 2nd edition (2010) published by Springer Science and Business Media LLC, www.springerlink.com.

Figure 4:

T4 Direct extension of tumour into ipsilateral adrenal gland.

From the American Joint Committee on Cancer (AJCC), Chicago, Illinois. The original source for this material is the AJCC Cancer Staging Atlas 2nd edition (2010) published by Springer Science and Business Media LLC, www.springerlink.com.

Table 1. Required data items for pathological reporting of invasive carcinoma of renal tubular origin.

CLINICAL	MACROSCOPIC	MICROSCOPIC
Specimen laterality	Accompanying /attached structures	Histological tumour grade -WHO/ISUP
Operative procedure	Tumour focality	Histological tumour type
	Maximum tumour dimension	Sarcomatoid morphology
		Rhabdoid morphology
		Necrosis
		Extent of invasion • Tumour spread beyond the renal capsule • Tumour in renal sinus • Tumour extends beyond Gerota's fascia • Tumour in major veins (renal vein or its segmental branches, inferior vena cava) • Tumour in pelvicalyceal system • Tumour in adrenal gland • Tumour in other organs/structures
		Lymph node status • Number of lymph nodes examined • Number of positive lymph nodes
		Margin status
		Coexisting pathology in non-neoplastic kidney
		Pathological Staging (TNM 8th edition) • TNM descriptors (as required) • pT category • pN category • pM category

Table 2. WHO Tumours of the Urinary System and Male Genital Organs, (fourth edition, 2016) classification of renal cell carcinoma.

Clear cell renal cell carcinoma
Multilocular cystic renal neoplasm of low malignant potential
Papillary renal cell carcinoma
Type 1
Type 2
Oncocytic
NOS
Chromophobe renal cell carcinoma
Hybrid oncocytic chromophobe tumour
Collecting duct carcinoma
Renal medullary carcinoma
MiT family translocation renal cell carcinoma
Xp11 translocation renal cell carcinoma
t(6;11) renal cell carcinoma
Other *Specify*
Mucinous tubular and spindle cell carcinoma
Tubulocystic renal cell carcinoma
Acquired cystic disease associated renal cell carcinoma
Clear cell papillary/tubulopapillary renal cell carcinoma
Hereditary leiomyomatosis and renal cell carcinoma-associated renal cell carcinoma
Succinate dehydrogenase (SDH) deficient renal carcinoma
Renal cell carcinoma, unclassified
Other *Specify*

Table 3. The World Health Organization/International Society of Urological Pathology grading system for clear cell and papillary renal cell carcinoma.

Grade 1	Tumour cell nucleoli invisible or small and basophilic at 400 x magnification
Grade 2	Tumour cell nucleoli conspicuous at 400 x magnification but inconspicuous at 100 x magnification
Grade 3	Tumour cell nucleoli eosinophilic and clearly visible at 100 x magnification
Grade 4	Tumours showing extreme nuclear pleomorphism and/or containing tumour giant cells and/or the presence of any proportion of tumor showing sarcomatoid and/or rhabdoid dedifferentiation

Table 4 Recommended data items for pathological reporting of invasive carcinoma of renal tubular origin.

CLINICAL	MACROSCOPIC	MICROSCOPIC	OTHER
Pre-operative treatment Tissue removed from specimen prior to submission	Tumour site(s) Block identification key	Extent of sarcomatoid component Extent of rhabdoid component Extent of necrosis Extent of invasion • Tumour in renal vein wall Lymphovascular invasion Lymph node status • Size of largest focus Extranodal extension	Ancillary findings

Table 5. The American Joint Committee on Cancer, Nodes and metastases staging system for renal cell carcinoma

Primary tumour (T)	TX Primary tumour cannot be assessed
	T0 No evidence of primary tumour
	T1 Tumour ≤ 7 cm in greatest dimension, limited to the kidney
	T1a Tumour ≤ 4 cm in greatest dimension, limited to the kidney
	T1b Tumour > 4 cm but ≤ 7 cm in greatest dimension, limited to the kidney
	T2 Tumour > 7 cm in greatest dimension, limited to the kidney
	T2a Tumour > 7 cm but ≤ 10 cm in greatest dimension, limited to the kidney
	T2b Tumour >10 cm, limited to the kidney
	T3 Tumour extends into major veins or perinephric tissues, but not into the ipsilateral adrenal gland and not beyond Gerota's fascia
	T3a Tumour extends into the renal vein or its segmental branches, or invades pelvicalyceal system, or invades perirenal and/or renal sinus fat but not beyond Gerota's fascia
	T3b Tumour extends into the vena cava below the diaphragm
	T3c Tumour extends into the vena cava above the diaphragm or invades the wall of the vena cava
	T4 Tumour invades beyond Gerota's fascia (including contiguous extension into the ipsilateral adrenal gland)
Regional lymph nodes (N)	NX Regional lymph nodes cannot be assessed.
	N0 No regional lymph node metastasis
	N1 Metastasis in regional lymph node(s)
Distant metastasis (M)	M1 Distant metastasis